Letter from Alexander Graham Bell to Mabel Hubbard Bell, May 26, 1899, with transcript

ALEXANDER GRAHAM BELL TO MABEL (Hubbard) BELL Beinn Bhreagh, C. B. Friday, May 26, 1899. Laboratory Notes. Dear Mabel:

I telegraphed you that laboratory experiments are very promising. In explanation I may say that experiments have revealed the fact that we have not been getting, out of the little electric motors we have been using, more than a small fraction of the power they are capable of exerting.

In order to gain greater propulsive power it seemed to be necessary to employ larger propellers — but larger propellers fastened to our small motors gave such poor results in the past that we have been obliged to use propellers of very slight diameter. The resistance of the air to the rotation of a large wing surface slowed down the motors to such an extent — that, at first, it seemed as though larger and more powerful motors would be necessary to produce any useful result. But larger motors are enormously heavier in proportion to their power than small ones. In fact it is a general law that the smaller an electro-magnet is — the greater is its attractive power in proportion to its weight. We have larger motors than those we have been using. The next size larger is four times as heavy — but I am sure that four small motors would yield more power.

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Before deciding to use more powerful motors — the experiment was made of giving the little ones the advantage of leverage — by belting the axis to a larger wheel — and attaching the propeller to the large wheel.

This arrangement is an arrangement for power not velocity. The large wheel must necessarily rotate more slowly than the small motor axis that turns it. Hence you might

expect that a fan wheel or vane attached to the large wheel would rotate more slowly — than if it were attached directly to the motor axis without any larger wheel and belting. But it does not. On the contrary the “fan” or “vane” or “wing-piece” or whatever you like to call it — rotates much more rapidly when attached to the large wheel.

A two winged vane when attached directly to the axis of a small motor made 91 rotations per minute. When attached to a wheel ten times larger than the motor pulley the vane made 293 rotations per minute.

This shows that we have not been utilizing the power of the small motors properly in attaching the propellers directly to the motor axis — the motor axis made 10 times as many rotations as large wheel or 2930 rotations instead of 91 as in the first case.

What an enormous lose of power was represented that 91! Mr. Ellis informed me that the agents from whom we purchased the motors claimed that they would rotate a fan wheel for ventilation purposes, 2000 times a minute — 3 but experiments show that this statement does not at all express the power of rotation of these motor axes under suitable conditions. With such rapid rotations it is of course impossible to count the rotations directly — but by means of the belting there is no difficulty in the matter.

By attaching a little piece of white string to the belting — the motion of the white object from one wheel to the other is quite easily perceptible — and we can count the number of times it makes the circuit in a given time. Then by turning the belting round slowly by hand — we can ascertain how many rotations of the large (or small) wheel correspond to one rotation of the white mark on the belt. In this way we found that our motor axis today was making 10560 rotations per minute! Not only this — but it was doing work at the time — causing, through the intermediary of a large pulley, rapid rotation in a large propeller. With such rapid rotation it is possible that the belting slipped somewhat — but if this happened it merely means that the rotation was more rapid than estimated. We can say certainly that there were at least 10560 rotations per minute. The musical note produced by the rotation

of the motor axis also indicated by its pitch that the frequency of rotation was of the order estimated.

I say then that our experiments are very 4 promising. With over 10,000 rotations per minute at our disposal what may we not hope to accomplish with our little motors.

The possibilities of power are much greater than I had deemed possible before our recent experiments were made.

A new whirling table for testing the propulsive powers of propellers of different kinds has been completed. A number of propellers have already been tried with interesting and suggestive results — but I must postpone description until the different Series have been tried.

Your loving husband, Alec. Mrs. A. Graham Bell, 1331 Connecticut Avenue, Washington D. C. U. S. A.